

# NASA TECH BRIEF

## *Langley Research Center*



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### Trace Contaminant Adsorption and Sorbent Regeneration in Closed Ecological Systems

In any closed ecological system, the buildup of trace contaminants from both metabolic processes and material degradation must be controlled by a suitable contaminant removal system. One such system uses activated carbon as a sorbent. Despite its use for many years, little or no information existed on activated carbon to give a quantitative estimation of its sorbent capacity, interference effects of multiple contaminants (including water vapor), and desorption rates under spacecraft regeneration conditions.

A detailed theoretical and experimental investigation was performed to evaluate the regenerable sorption of carbon. As a result of the investigation, correlation was obtained that allows the sorptive capacity of carbon to be determined for a given system. This correlation, which extends to adsorption potential-theory parameters, applies to both pure and mixed contaminants under dry and humid conditions and at various temperatures. Vacuum desorption rates were investigated for both single particles and for sorbent beds. In single-particle studies, it is shown that the rate-determining step is desorption from the external particle surface. Thus, the rate is inversely proportional to the particle diameter.

For vacuum desorption from sorbent beds, the rate-determining step is Knudsen diffusion through inter-particle voids. The Knudsen diffusivity has been experimentally measured. Although the single-particle studies showed that smaller particles desorb faster, the theory correctly predicts the surprising result that the opposite is true for beds, i.e., beds composed of large particles desorb faster than those containing smaller particles. The desorption rate dependency on bed geometry,

adsorption isotherm, and initial gas phase concentration is also contained in the theory. The theoretical predictions agree with experimental measurements.

In the course of this work a theory was derived and successfully tested for desorption rates from single particles and from beds such as those used in spacecraft atmospheric trace-contaminant control systems. Extensive desorption rate data for both single carbon particles and packed beds were compiled and are presented graphically. These data are for typical trace contaminants found in spacecraft environments, such as n-butane, toluene, and propane.

#### Note:

The following documentation may be obtained from:  
National Technical Information Service  
Springfield, Virginia 22151  
Single document price \$3.00  
(or microfiche \$0.95)

Reference: NASA CR-1582, (N70-38501), Trace Contaminant Adsorption and Sorbent Regeneration.

#### Patent status:

NASA has decided not to apply for a patent.

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